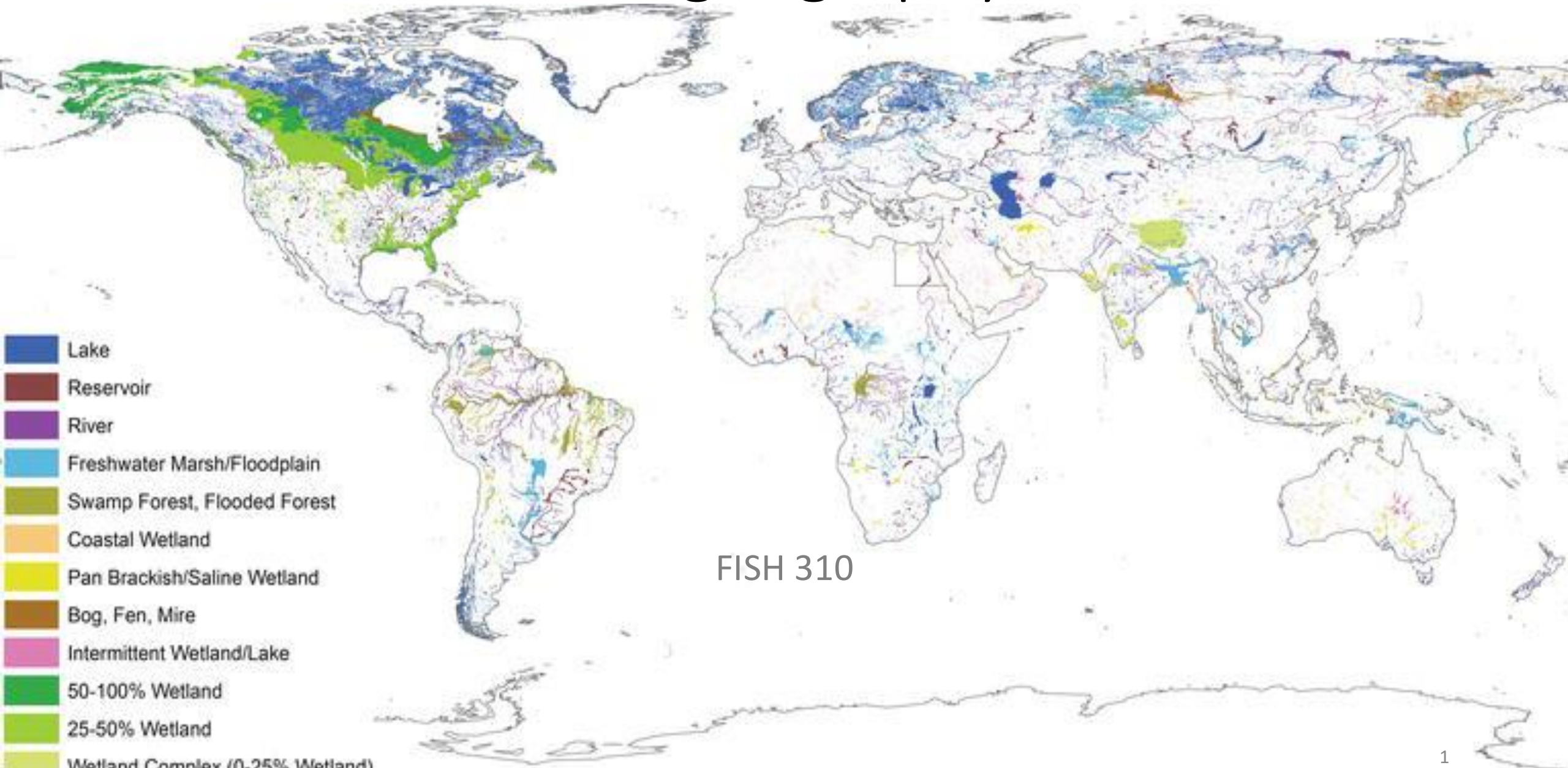
Zoogeography



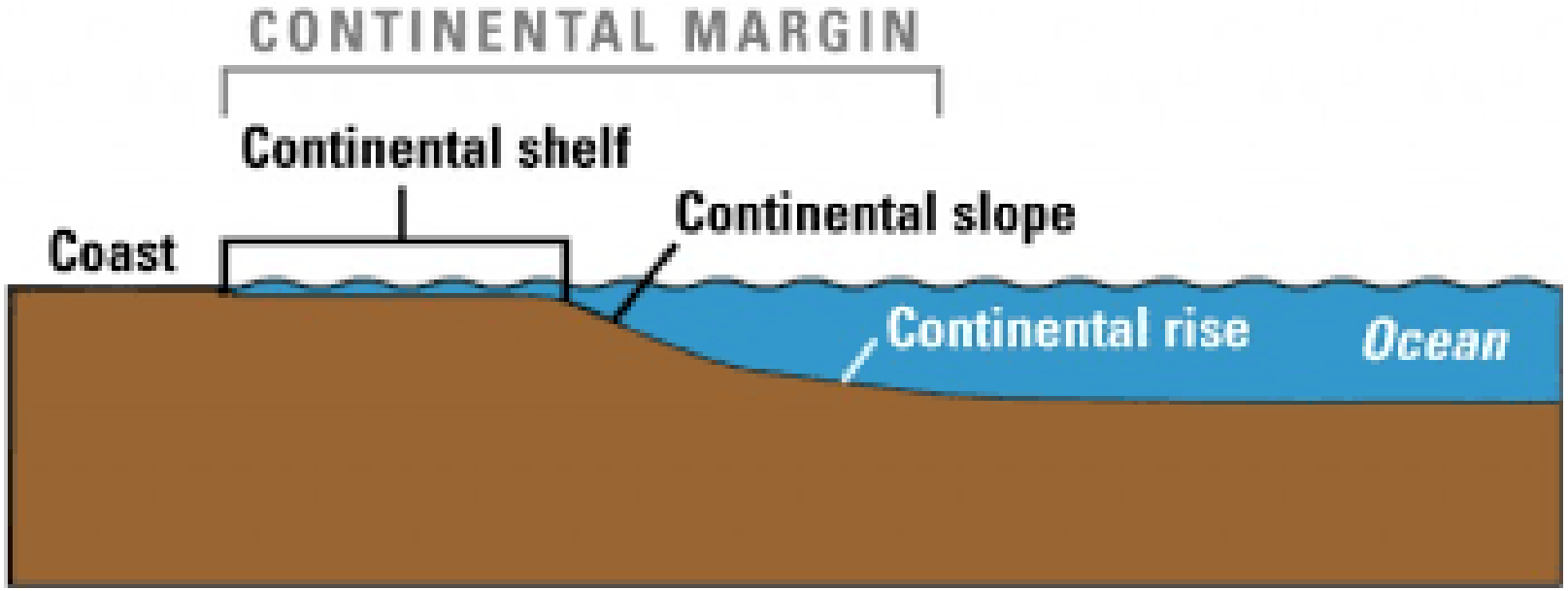
FISH 310

Today's roadmap

- **Marine fish biogeography**
  - **Ecological divisions of fishes**
  - Zoogeographic regions of fishes
- Freshwater fish biogeography
  - Zoogeographic regions of fishes
  - Connections between South American and African freshwater faunas
  - Disjunction between North and South America

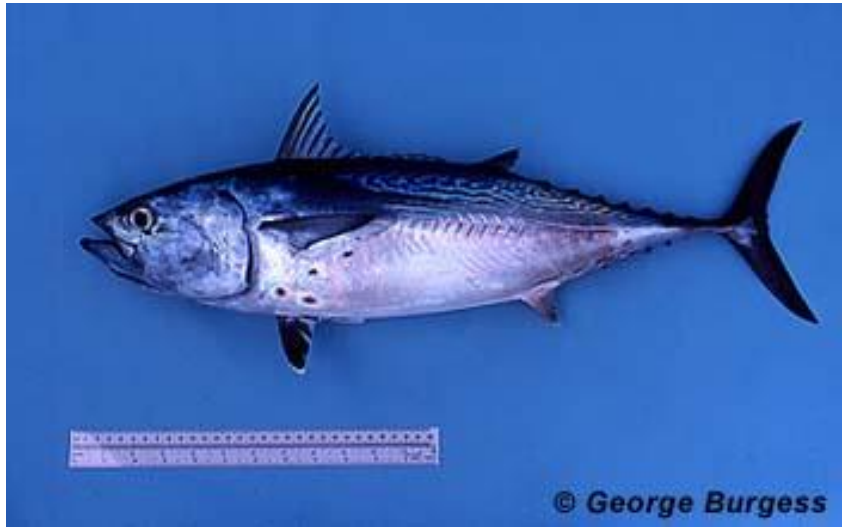
Four Major Ecological Divisions of Marine Fishes

1. **EPIPELAGIC** fishes (1.6% of marine fishes, 360 spp.) = surface to 200 m depth
2. **DEEP PELAGIC** fishes (5%, 1400 spp.) = dwell in the water column
    1. **MESOPELAGIC** = 200 - 1000 m
    2. **BATHYPELAGIC** = > 1000 m
3. **DEEP BENTHIC** fishes (6.4%, 1800 spp.) = bottom-dwelling > 200 m
4. **LITTORAL or CONTINENTAL SHELF** fishes (45%, 12600 spp.) = shore and shelf-dwelling fishes < 200 m

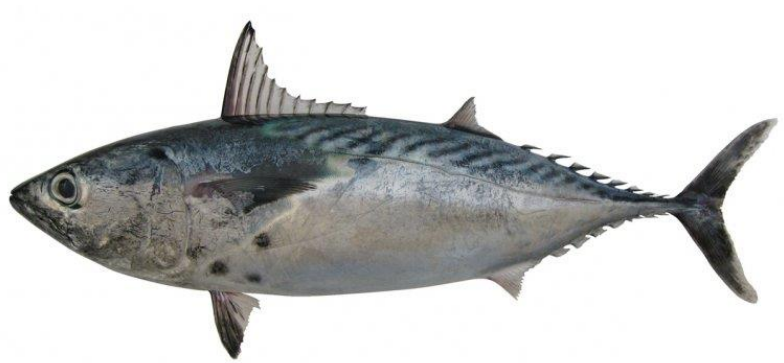


Epipelagic fishes

- Epipelagic taxa often have **worldwide** distributions, but inshore epipelagic taxa generally have **restricted** distributions
- **Allopatric speciation** results in interesting distribution patterns



Euthynnus alletteratus
Atlantic



Euthynnus affinis
Indo-West Pacific

Euthynnus lineatus
Eastern Pacific

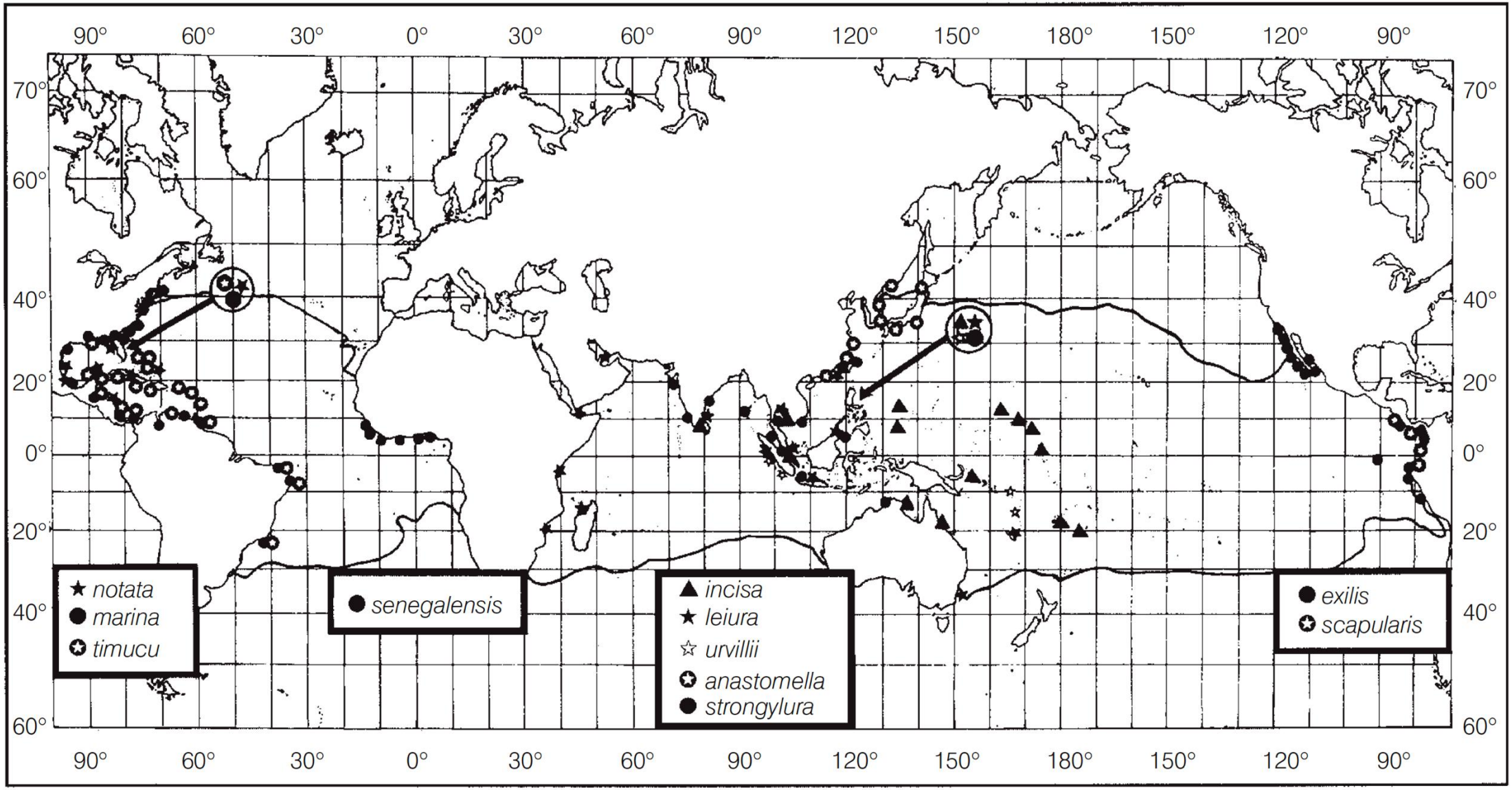
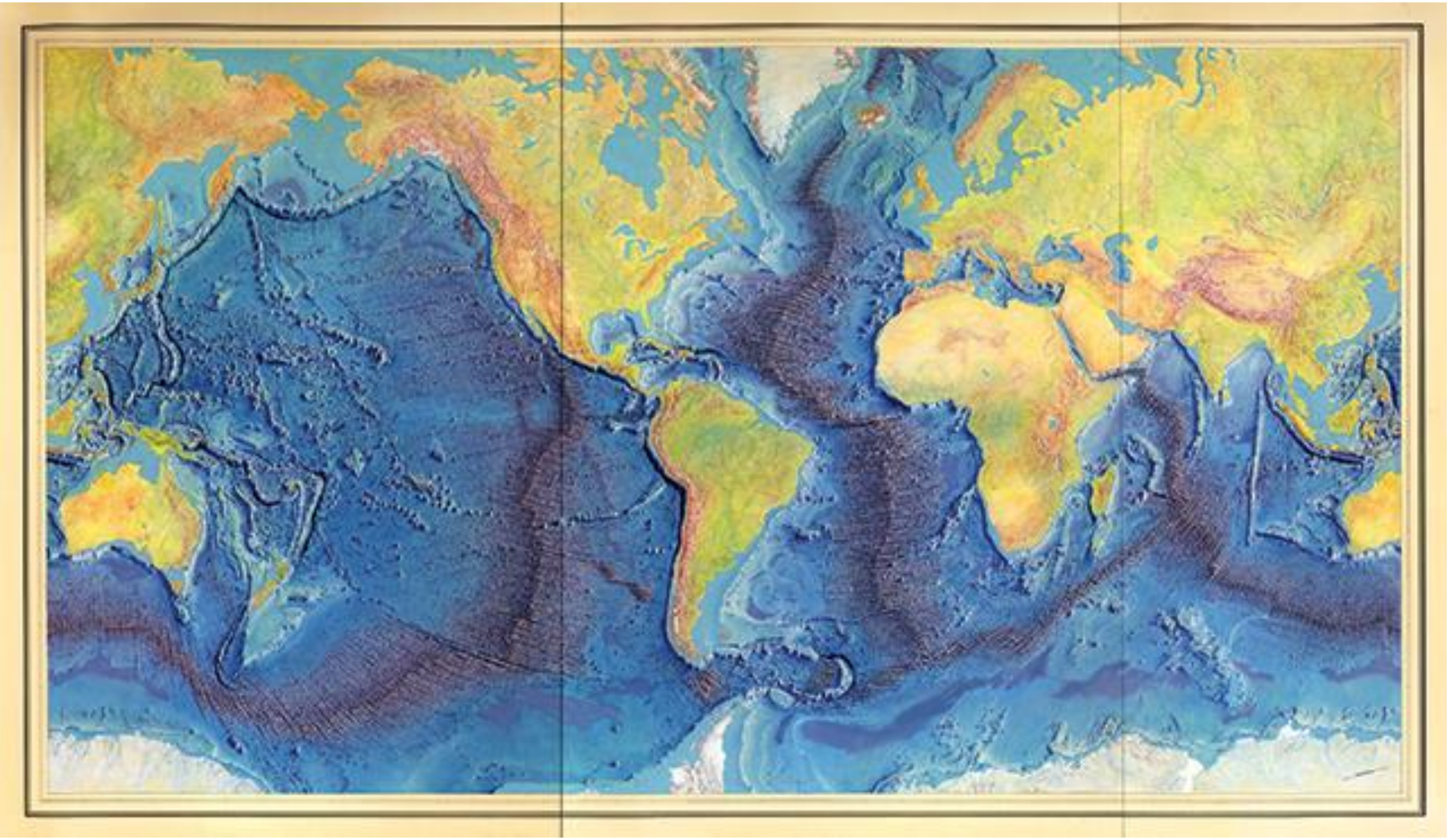


Figure 16.2

Distribution of marine populations of 11 species of needlefishes of the genus *Strongylura* in relation to the 23.9° isothere. Adapted from Cressey and Collette (1970).

Deepwater fishes

- Why can’t we rely on surface maps of the ocean for understanding the biogeography of deepwater fishes?



Littoral fishes

- Greatest diversity of fishes is in tropical waters – why?
  - Coral reefs restricted to < 100 m, > 18 º C, and clear water

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Indo-West Pacific region

- S. Africa & Red Sea east through Indonesia & Australia to Hawaii & the S. Pacific Islands; 1/3 of all species of shallow marine fishes (~3000 spp.)
- Marine biodiversity global maximum = Indo-Malay-Philippines Archipelago

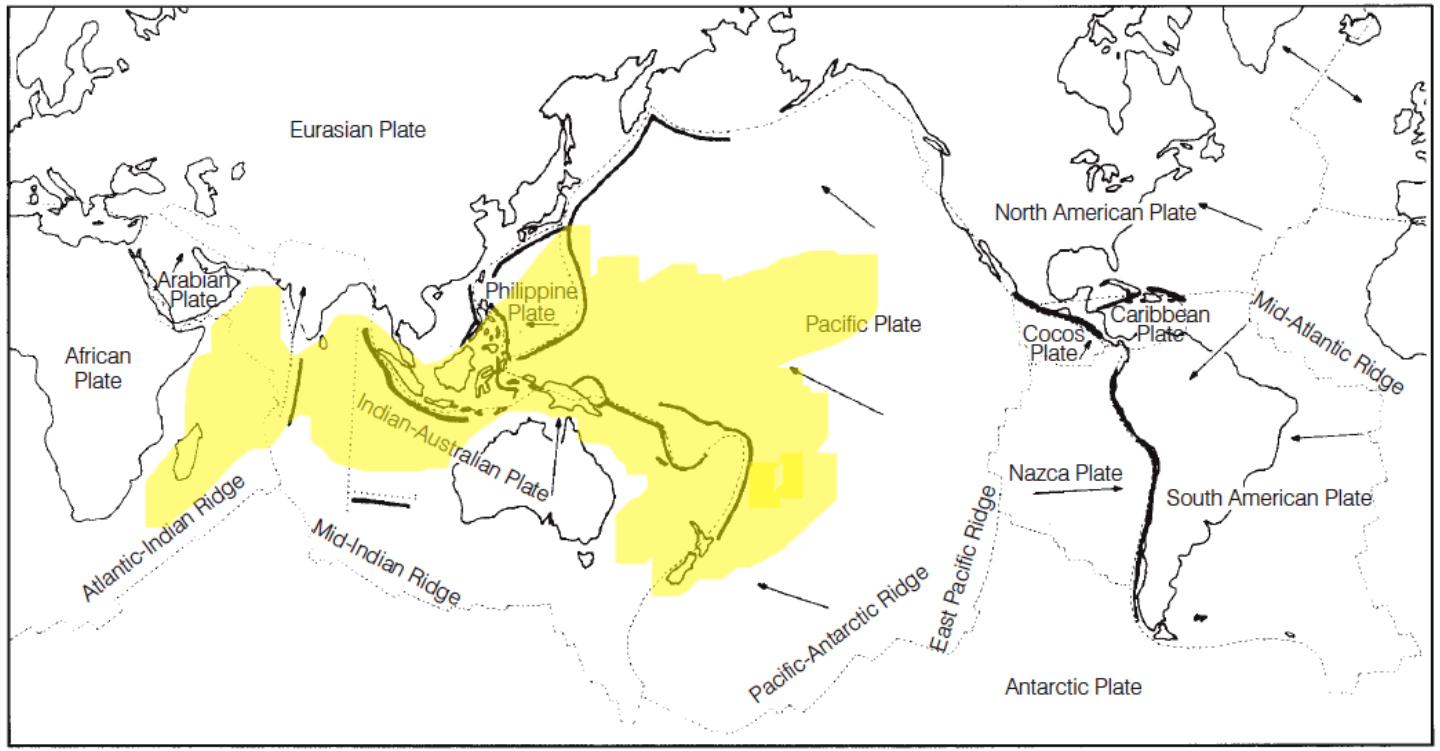


Figure 16.3
The earth's important tectonic features. Dashed lines denote margins of major lithospheric plates; arrows indicate direction of plate movements. Adapted from Springer (1982).

Western Atlantic region (~1200 spp reef fishes)

- N. America (temperate), Gulf of Mexico, Caribbean Sea, S. America (tropical + temperate)
- Max. diversity of toadfishes & a few other families!

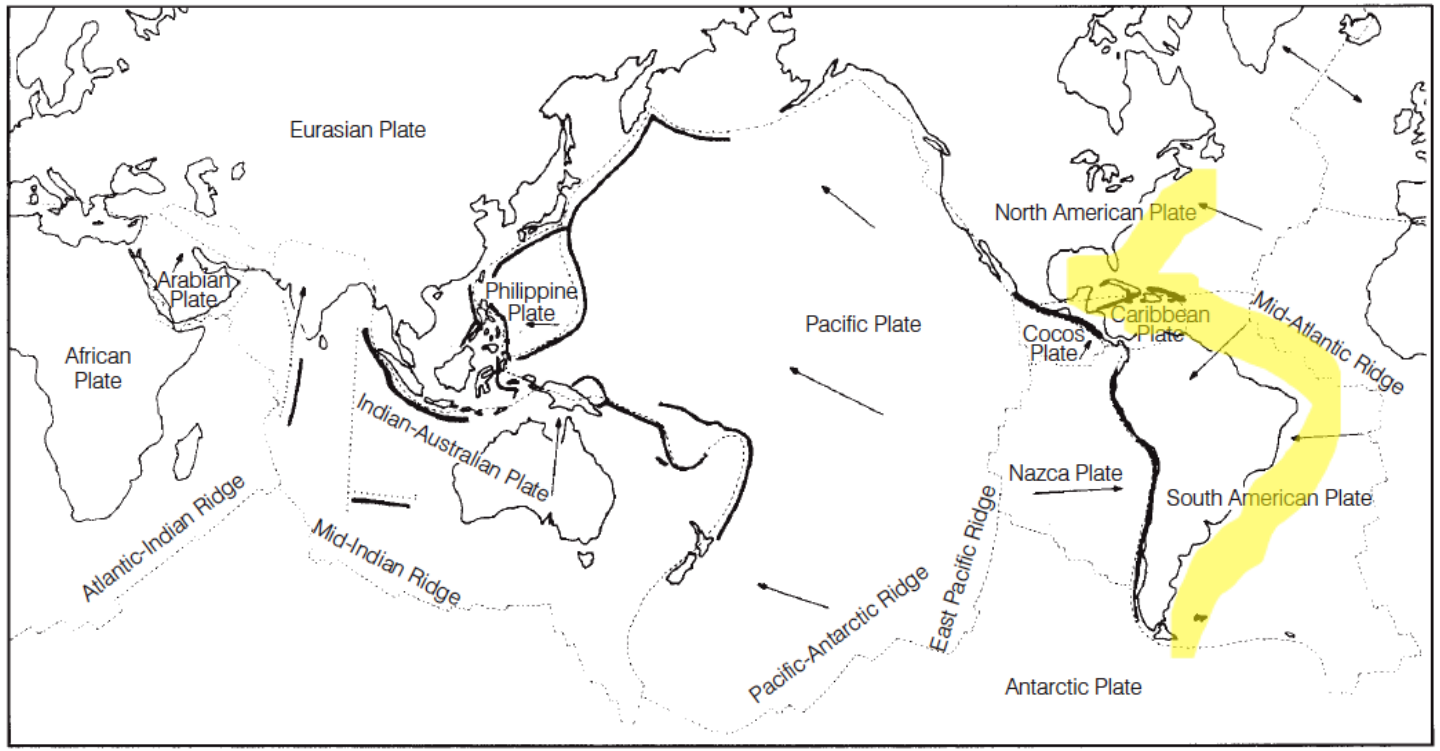


Figure 16.3
The earth's important tectonic features. Dashed lines denote margins of major lithospheric plates; arrows indicate direction of plate movements. Adapted from Springer (1982).

Eastern Pacific region

- Eastern Pacific Barrier = open water between central & s. Pacific islands & mainland American continents; limits movement of 86% of shore species from the central pacific
- Panamanian Isthmus: separated E. Pacific & W. Atlantic taxa ~3 mya
  - Note: Panama Canal has Lake Gatun in the middle + freshwater locks to transport ships, limiting transport of marine species

Eastern Atlantic region

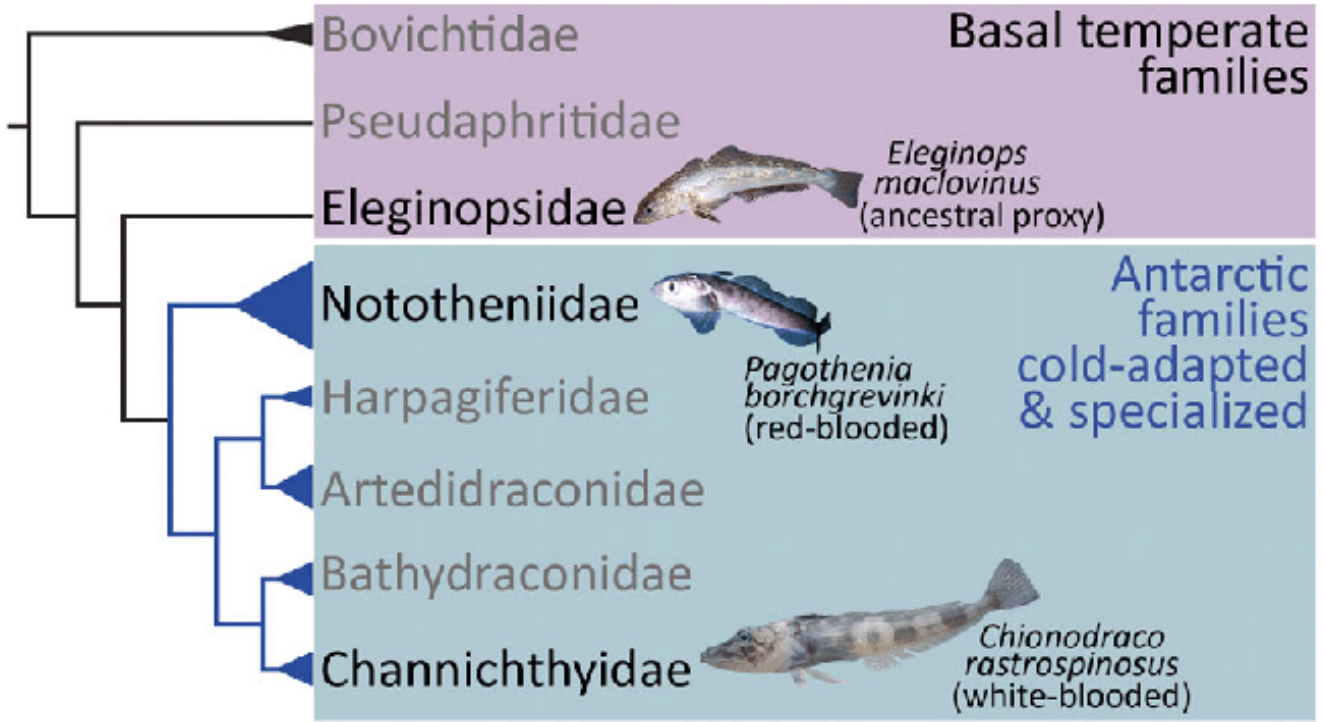
- Tropical shore fishes restricted to the Gulf of Guinea (basically from Senegal to Angola)
- Depauperate relative to Western Atlantic in terms of taxonomic diversity

Mediterranean Sea

- **Messinian Salinity Crisis** (5.9 – 5.3 Ma): Mediterranean Sea almost completely desiccated, ended with the Zanclean Flood (influx of Atlantic water into the basin)
- Cool Straits of Gibraltar prevent warm water fishes from moving from Gulf of Guinea north into eastern Mediterranean
- These two factors result in an overall depauperate fauna (~540 spp)

Arctic & Antarctic Fishes

- ~538 spp. between the two regions, many endemic taxa
- Usually higher Pacific diversity than Atlantic diversity in Arctic regions
- 90% of Antarctic fishes are from the Notothenioidei
- Antitropical disbtributions = present in temperate waters on both sides of the equator
- Tropical submergence = fishes continue ranges into tropical waters, by increasing depth (”following” the cold)



Today's roadmap

- Marine fish biogeography
  - Ecological divisions of fishes
  - Zoogeographic regions of fishes
- **Freshwater fish biogeography**
  - **Zoogeographic regions of fishes**
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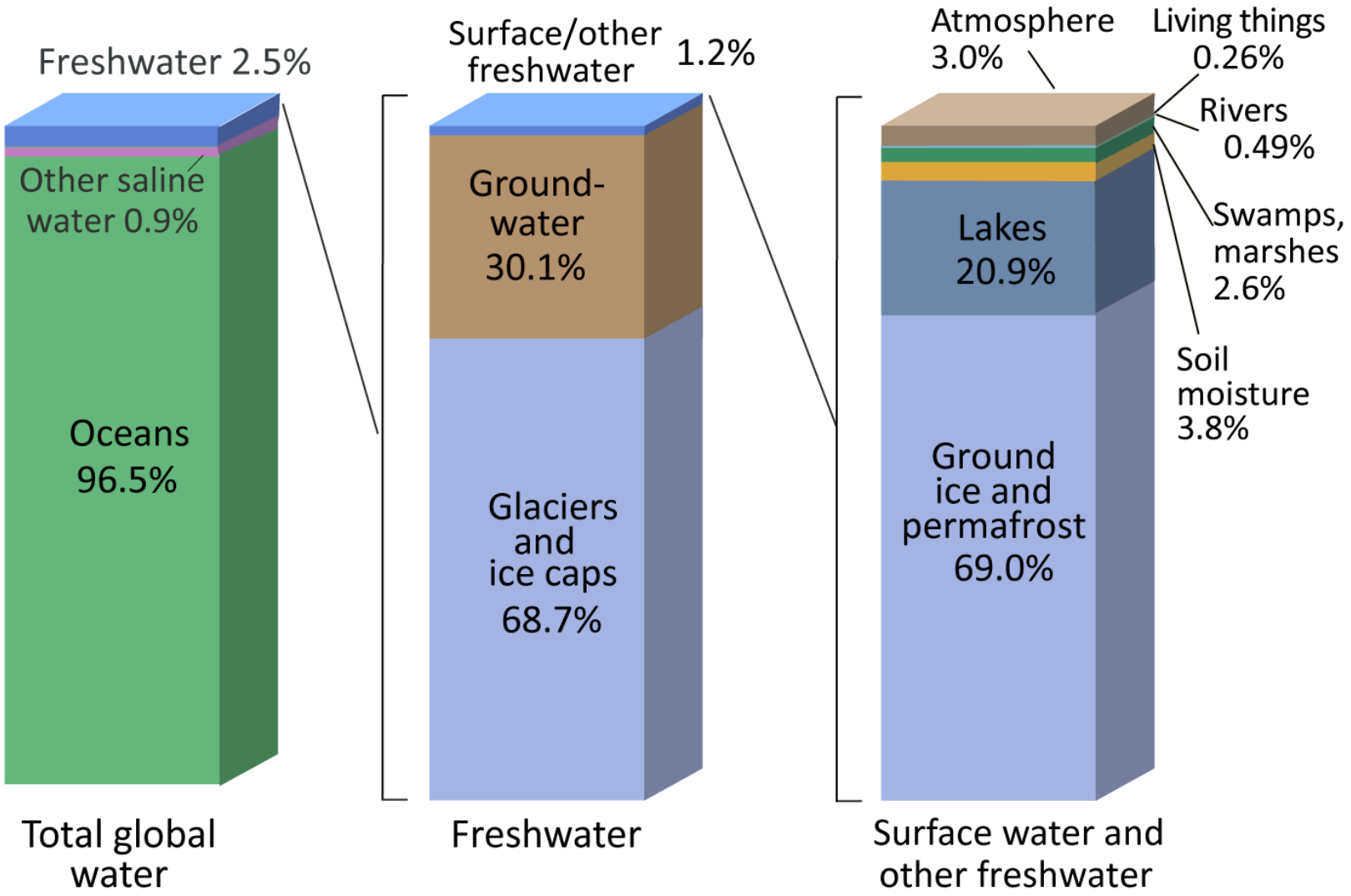
Where is Earth's Water?



41% of the world's fish species are freshwater

½ of all fish species live in <1% of the planet's water

WHY?

Credit: U.S. Geological Survey, Water Science School. https://www.usgs.gov/special-topic/water-science-school
Data source: Igor Shiklomanov's chapter "World fresh water resources" in Peter H. Gleick (editor), 1993, Water in Crisis: A Guide to the World's Fresh Water Resources. (Numbers are rounded).

Freshwater fishes vs. fishes in fresh waters

- **Primary** fw fishes: members strictly confined to fw
- **Secondary** fw fishes: members generally restricted to fw, but may enter sw
- **Peripheral** fishes have taken up more or less permanent residence in fw but spend some of their life cycle in fw and some in marine habitats (e.g. diadromous fishes)
- In regions that have never been connected w/continents (e.g. volcanic islands) *all native fishes in fw are secondary or peripheral species*!

Nearctic region

- N. America south to the Mexican plateau
- N. American fish fauna is the best mapped and known in the world!
- Contains 10 **ichthyological provinces**
    1. Pacific Coastal
    2. Great Basin
    3. Colorado
    4. Rio Grande
    5. Mississippi
    6. Atlantic Coastal
    7. Great Lakes-St. Lawrence
    8. Hudson Bay
    9. Arctic
    10. Mexican Transition

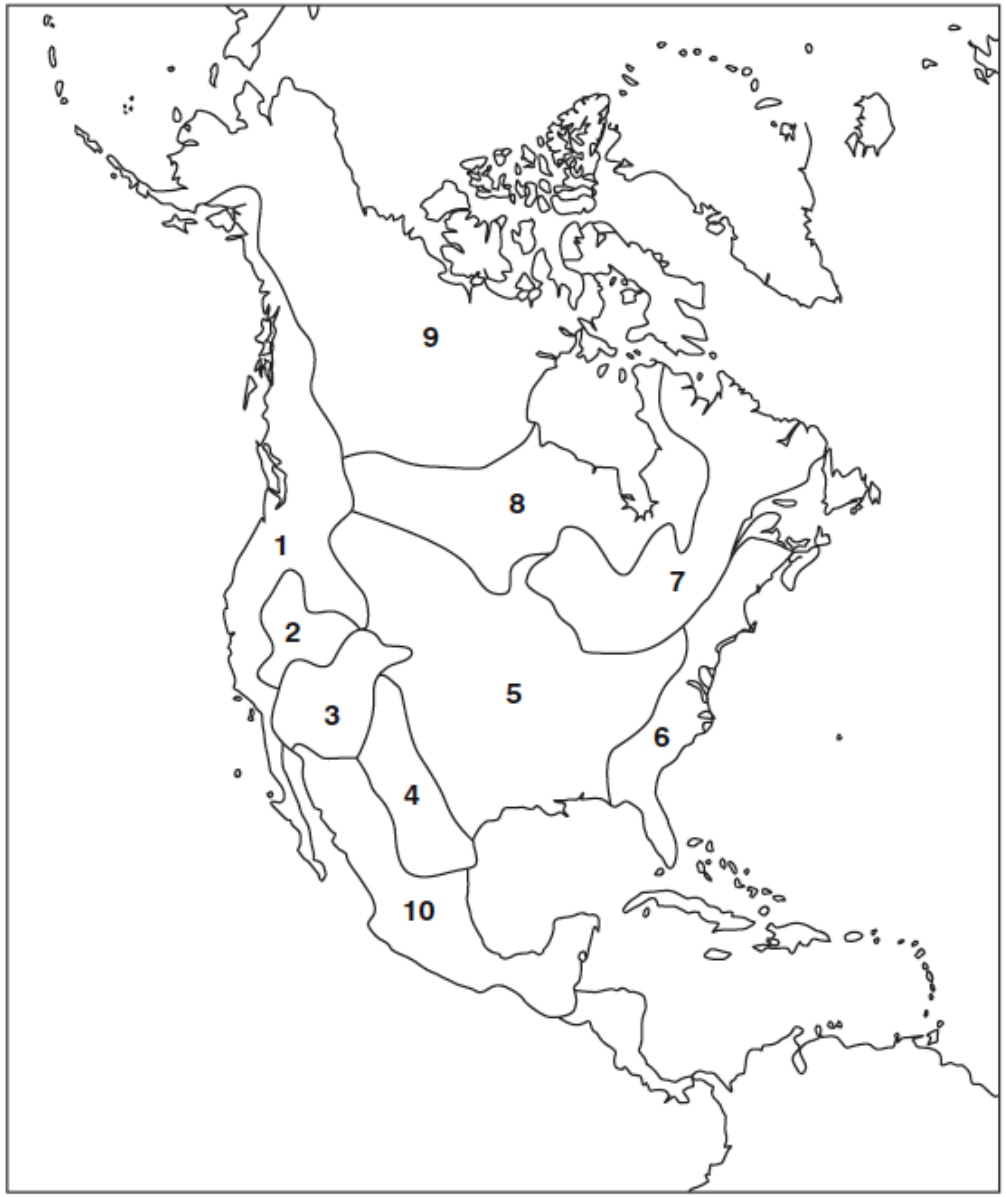


Figure 16.8
Main ichthyological provinces in North and Middle America. Numbers refer to regions in the text. From Lévêque et al. (2008).

Neotropical region

- S. America & Middle America
- S. America has largest freshwater fish fauna in the world!
- Contains 10 **ichthyofaunal provinces**
  1. South Patagonian
  2. North Patagonian
  3. Trans-Andean (South)
  4. Lake Titicaca
  5. Paranean
  6. South-East Brazilian
  7. East Brazilian
  8. Guianean-Amazonian
  9. North Venezuelan
  10. Trans-Andean

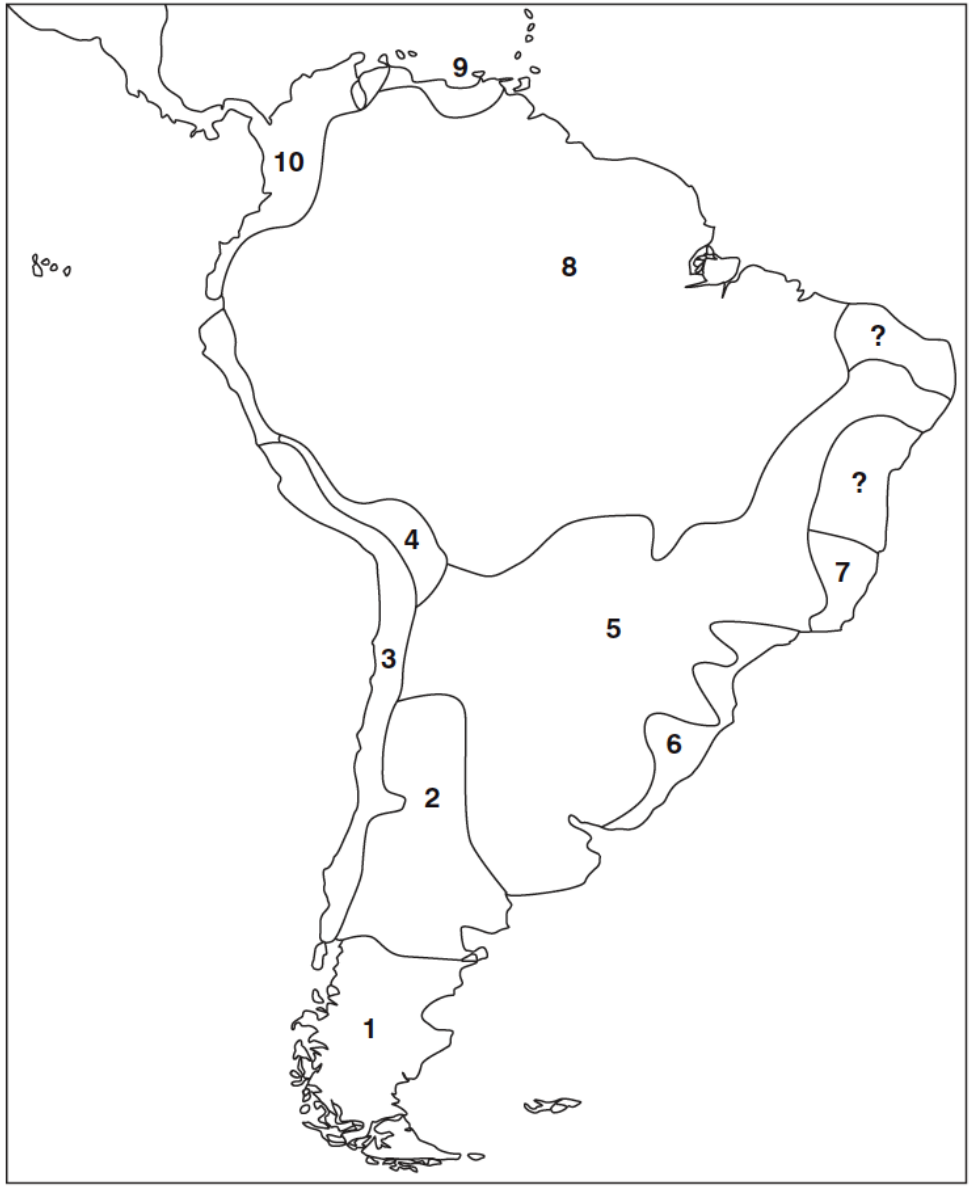


Figure 16.9
South American ichthyological provinces. Numbers refer to regions in the text. From Lévêque et al. (2008).

Palearctic region

- Northern Europe & Asia
- Just 14 families of primary freshwater spp.
- Contains 7 **ichthyofaunal provinces**
    1. Ponto-Caspian
    2. Northern Europe
    3. Western Europe
    4. Central Europe
    5. Central Peri-Mediterranean
    6. Eastern Peri-Mediterranean
    7. Iberian Peninsula

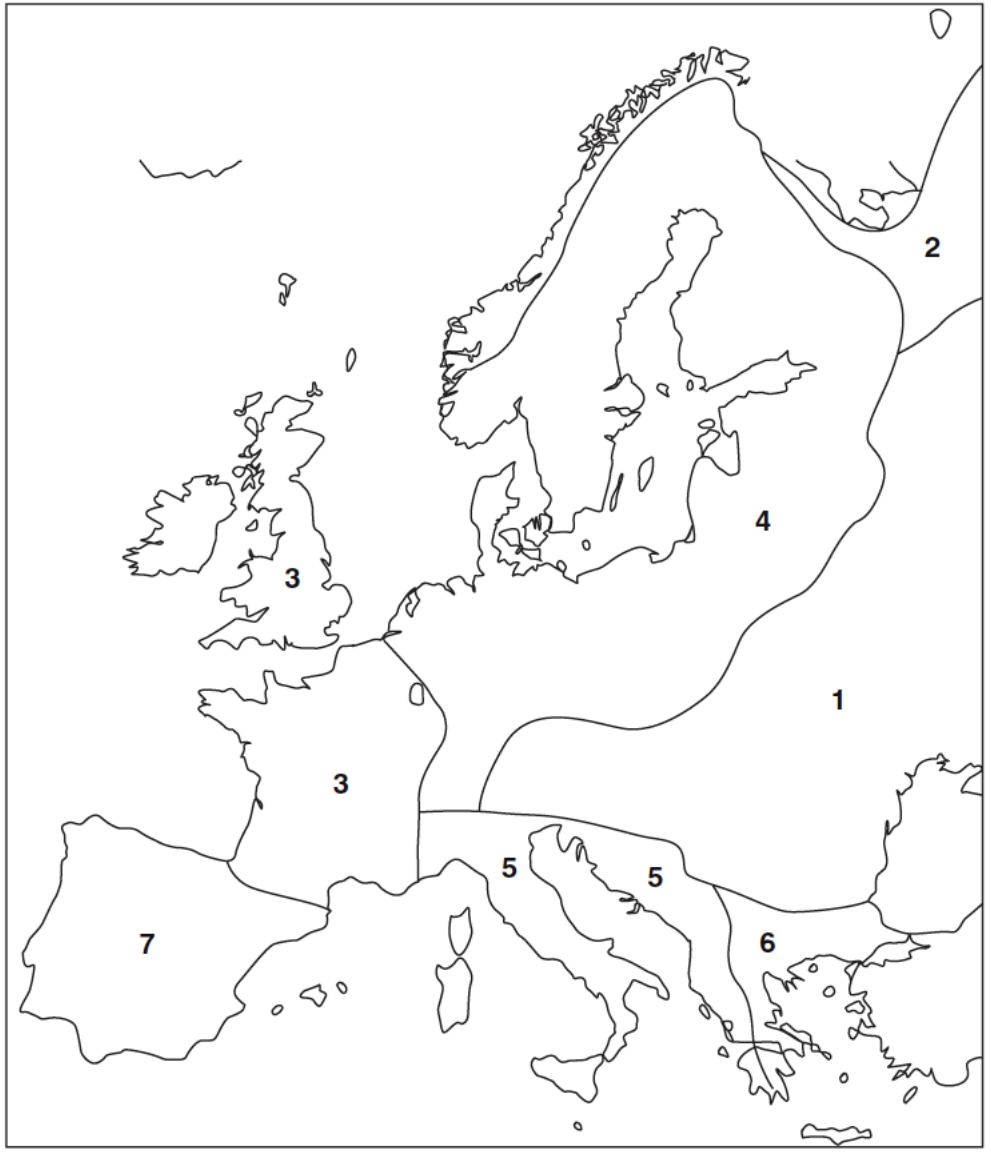


Figure 16.10
Main ichthyological provinces in western Europe. Numbers refer to regions in the text. From Lévêque et al. (2008).

African region

- 27 primary freshwater families & multiple primitive species (archaic distributions)
- Contains 10 **ichthyofaunal provinces**
  1. Maghreb
  2. Nilo-Sudan
  3. Upper Guinea
  4. Lower Guinea
  5. Congo
  6. Quanza
  7. Zambezi
  8. East Coast
  9. Southern
  10. Madagascar

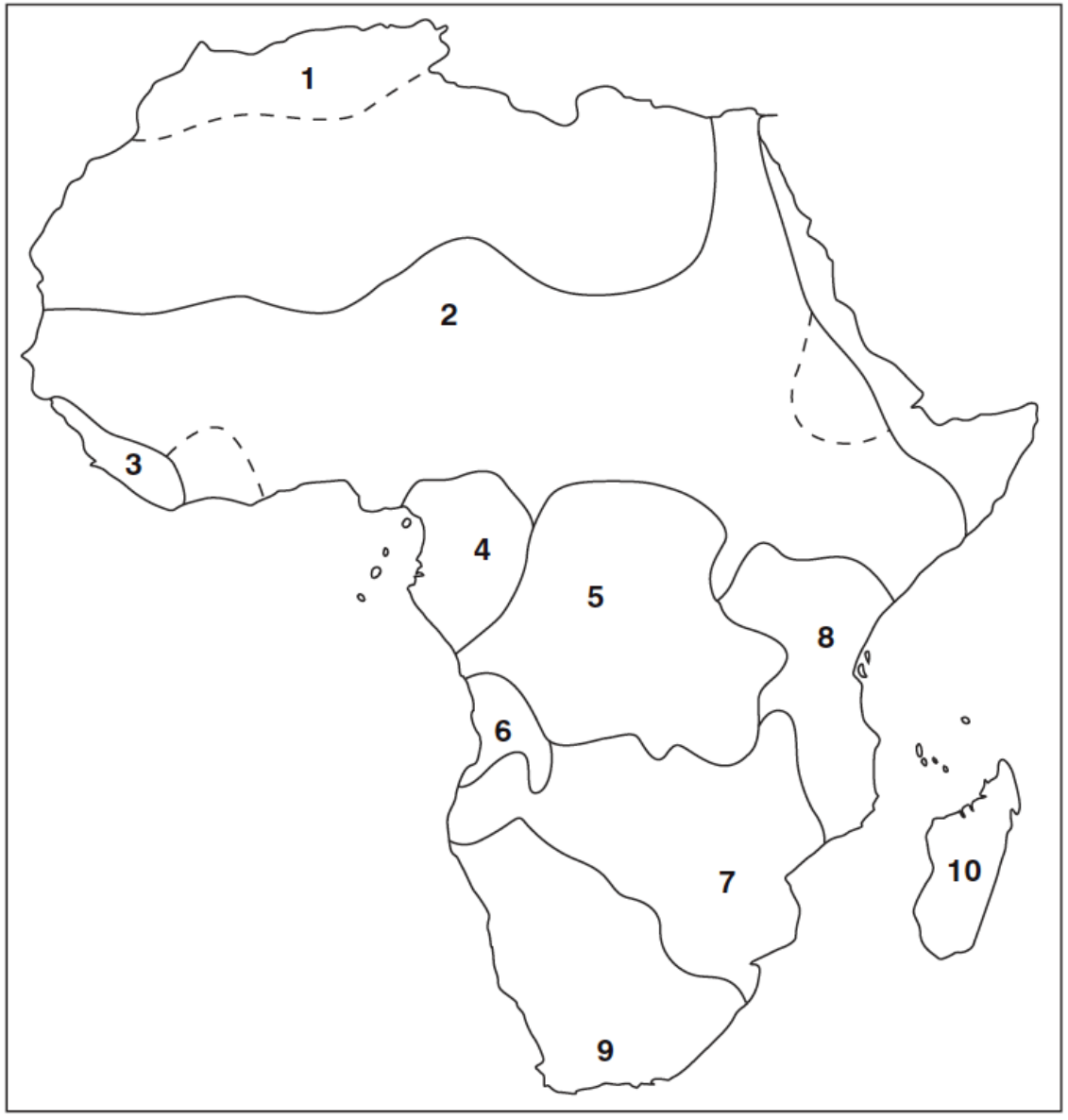


Figure 16.11

Main ichthyological provinces in Africa. Numbers refer to regions in the text. From Lévêque et al. (2008).

Oriental vs. Australian Regions

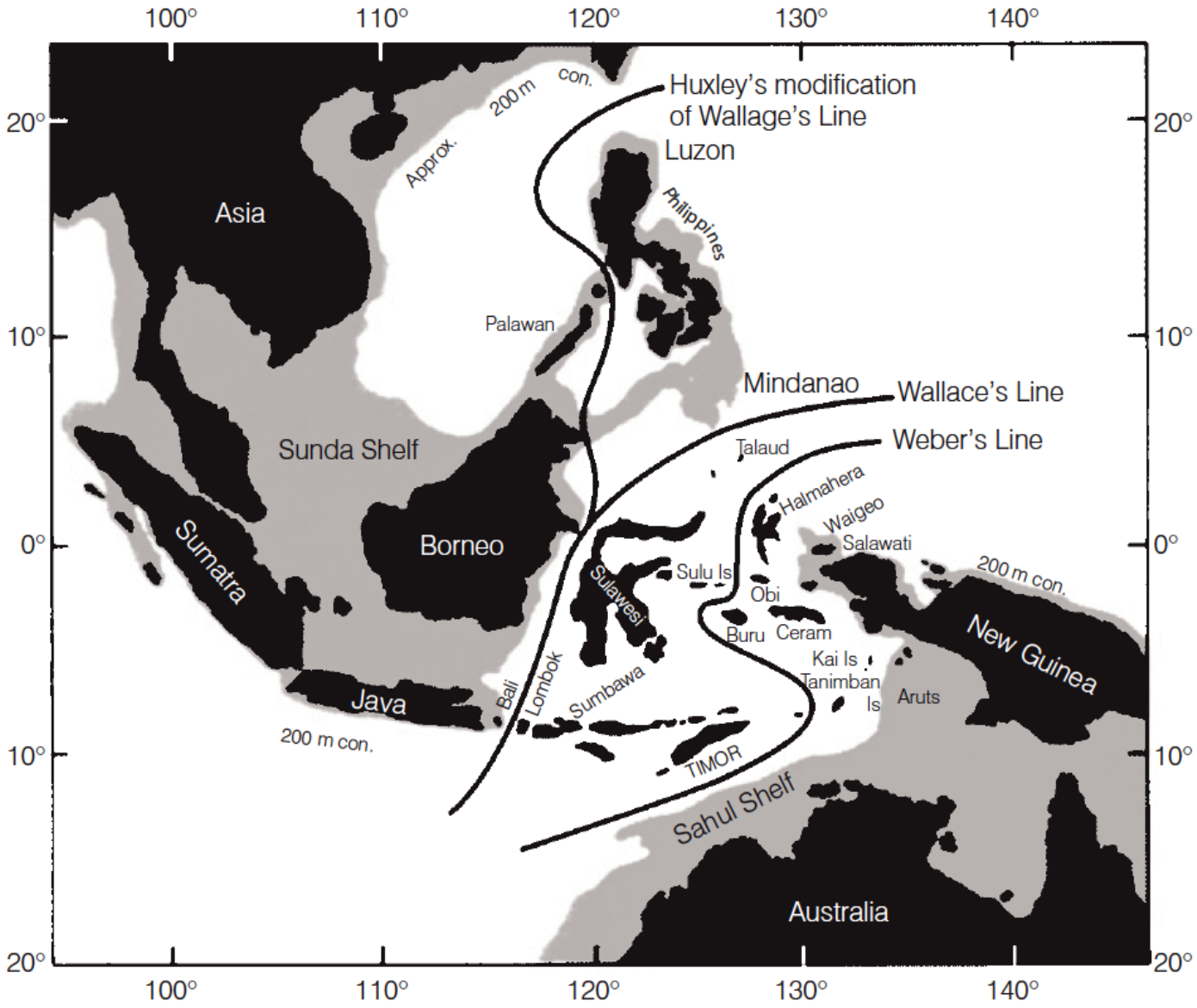


Figure 16.12

Wallace's and Weber's lines separating the Oriental and Australian regions. The shaded areas show how the major landmasses would be connected if the sea retreated to the 200 m line. Adapted from Berra (2007).

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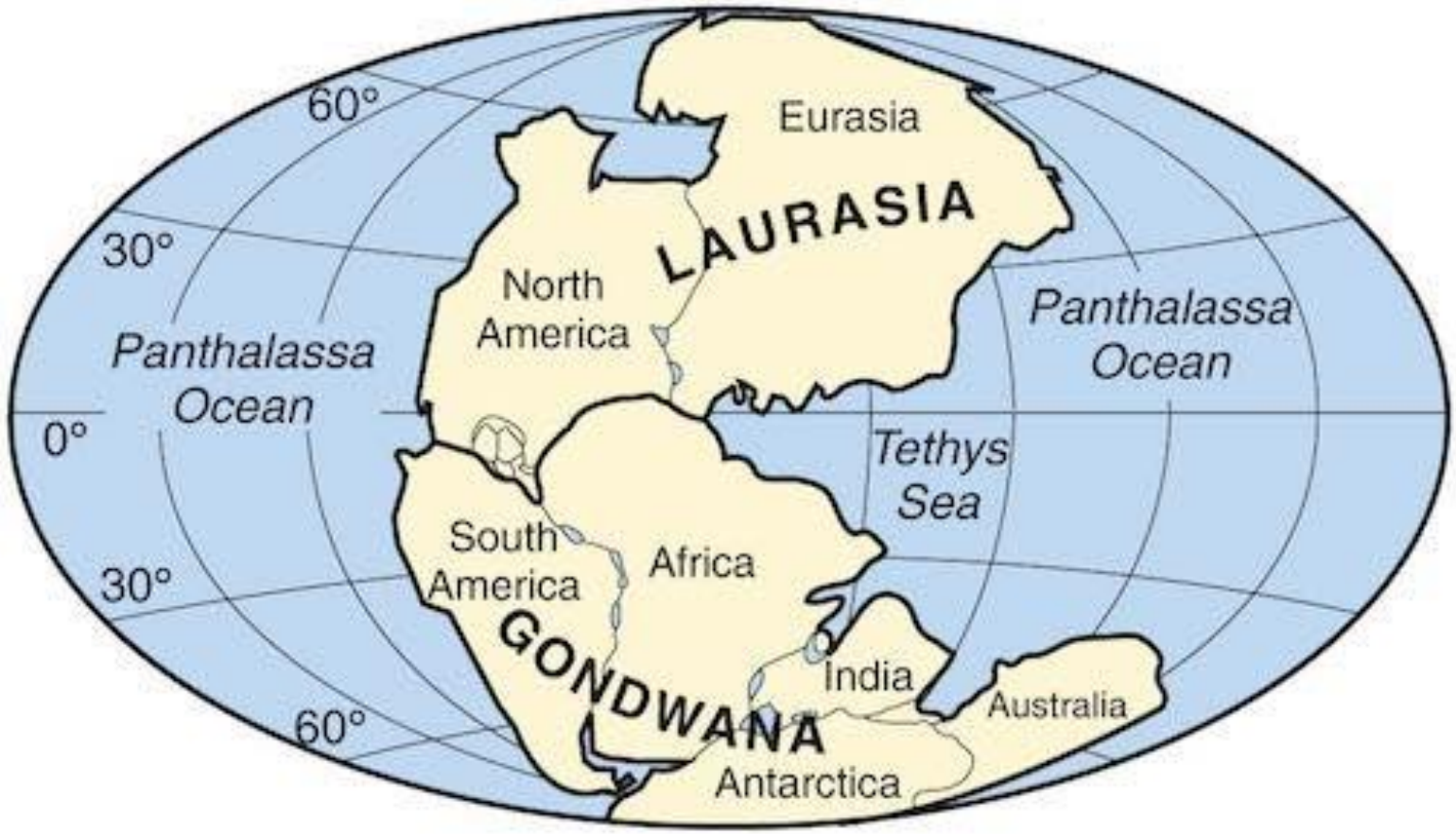
Connections between South American and African freshwater faunas

- S. Am., Africa, and Australia linked by presence of Osteoglossomorpha & Dipnoi, and Characiformes & Cichlidae both in Africa & S. America
- Is this due to **dispersal**? or **vicariance**?



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Middle America as a **filter barrier**

- Slows movement of freshwater fishes, resulting in very different faunas between N. and S. America

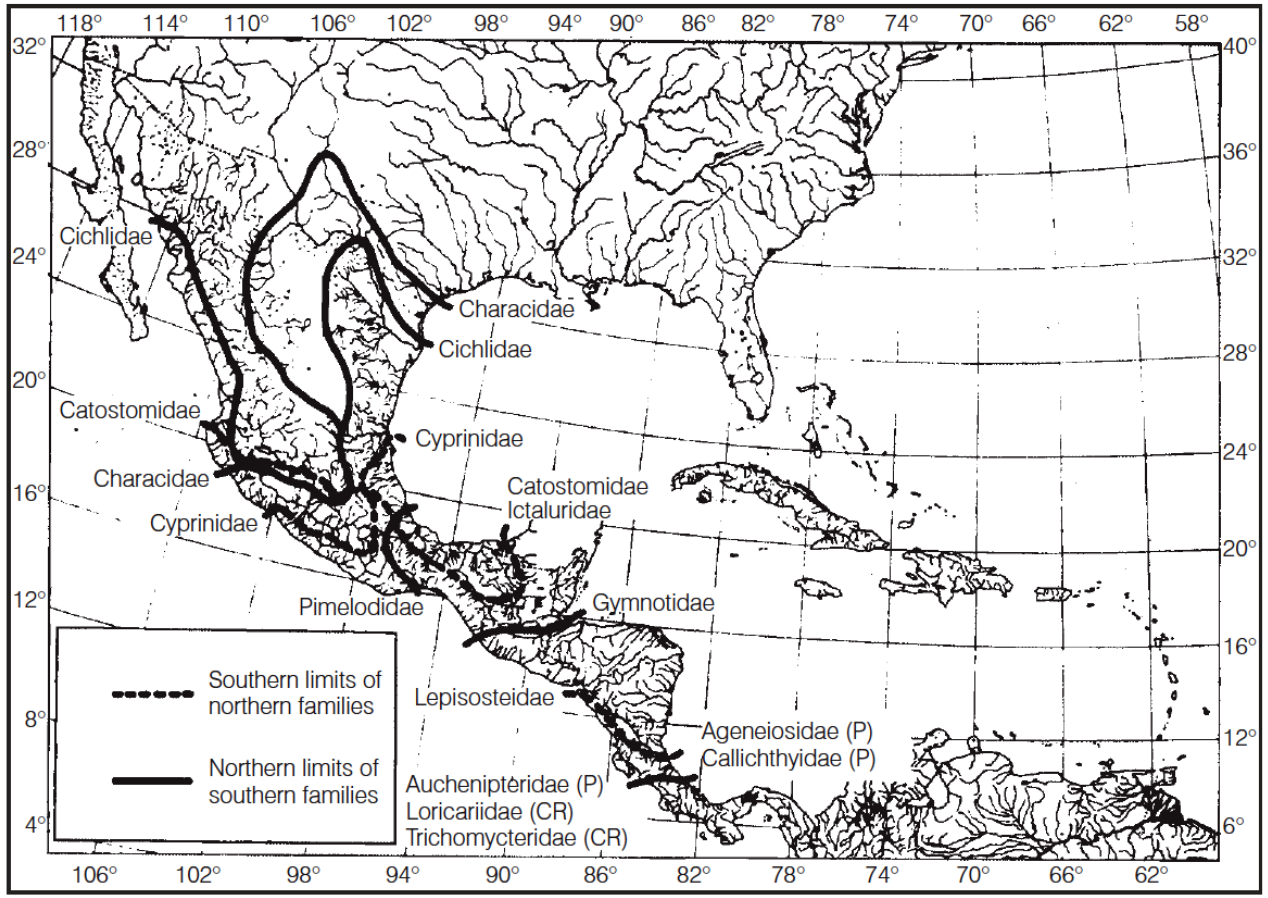

Figure 16.22

Distributional limits of certain primary and secondary freshwater fishes in Central America. A single characin (*Astyanax mexicanus*) and a single cichlid (*Cichlasoma cyanoguttatum*) reach north to the Rio Grande. CR, Costa Rica; P, Panama. Adapted from Miller (1966, fig. 1).